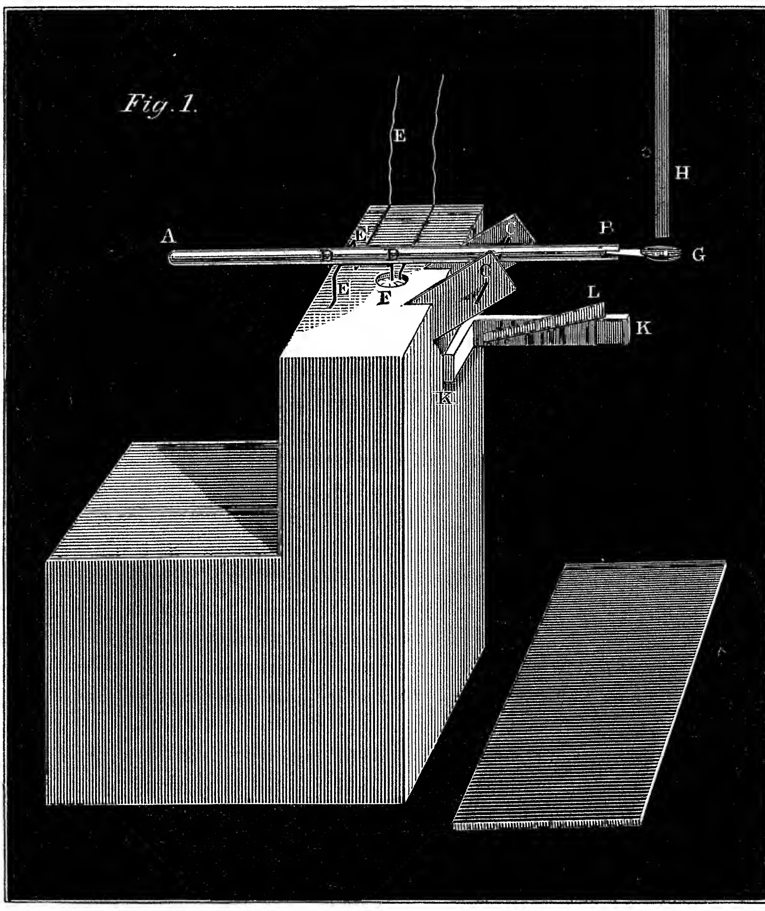
III. "A Second Paper on the Forms assumed by Drops of Liquids falling vertically on a Horizontal Plate." By A. M. Worthington. Communicated by B. Stewart, F.R.S. Received December 28, 1876.

In a previous paper* which I had the honour of submitting to the Society, a method was described by which the later stages of the oscillation had been seen. I wish now to supplement that paper with an account of the earlier stages. The experiments of the sequel were, by the kind permission of Professor Balfour Stewart, made this autumn in the Physical Laboratory at Owens College.

The arrangement that was found most successful for seeing the earlier



* See *ante*, p. 261.

stages was one by which the support was withdrawn from under a drop, so as to leave it free to fall, while at the same instant an electrical circuit was broken.

The apparatus is drawn in the accompanying fig. 1.

A B is a wooden rod about 6 inches long, turning about a horizontal axis C C. When the rod is horizontal, a platinum wire D D, bound to the underside, rests with one end on a platinum wire E E E, forming a bridge, while the other end dips into a mercury-trough F, so that, with the rod in this position, a current can pass from E to F, and so on through the coils of the electromagnet of the relay described in my previous paper.

The end B of the rod bears a little glass cup G made of the central part of a watch-glass, covered with an adherent coating of smoke, obtained by dipping the glass in paraffin-oil before smoking, on to which a drop of water or mercury can be lowered from the vertical tube H, so as to lie in the cup without adhering to it. A smart fillip with the thumb knocks up the end A, and sends down the end B with the cup, thus removing the support of the drop, and, of course, at the same time breaking the contact between D and E. K K is a wooden support bearing a slip of card L, which acts as a spring-catch, and prevents the rod from rebounding. The relay, described in the last paper, is then adjusted, so that the primary spark of the Ruhmkorff's coil is obtained, and the drop seen by it at any stage desired, whether in the air above the plate, at the moment of impact, or later.

A few precautions are necessary.

The cup G must be smoked even with mercury, as that liquid adheres slightly to glass, but not perceptibly to a smoked surface. With water or milk it requires frequent resmoking.

With a very large drop a cup of much deeper concavity must be used, otherwise the drop lies flattened out on the cup; and when the support is removed, efficiency is given to the curvature at the sides, by the tension of which the lower part of the drop is driven downwards into a column, which splits into two or more drops.

I was also able to see the early stages with mercury by fixing the two terminal wires of the electromagnet-current close under the end of a vertical tube, from which the drops were allowed to fall directly on to the plate. The convex end of the liquid, just before the drop fell, joined the two terminals and allowed the current to pass, and when the drop fell contact was broken.

But the time of the spark was not quite so constant as in the method just described, nor was the plan applicable to water, the conductivity of which, even when strongly acidulated, was too slight.

I noticed that, even when the spring of the relay was at its maximum tension, and the point of the relay-wire only just in contact with the mercury, the earliest spark that could be obtained showed that the drop

had already fallen about 20 millims. This explains the failure of the method described in my previous paper to show the earliest stages.

Set 1.

Fig. 1.

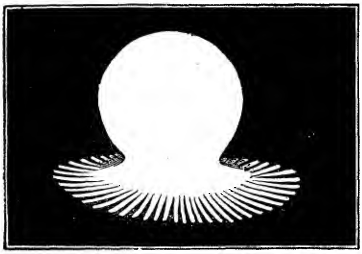


Fig. 2.

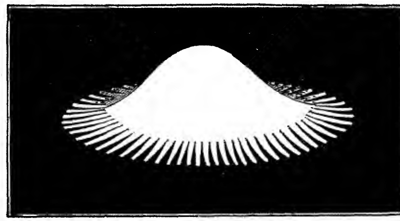


Fig. 3.

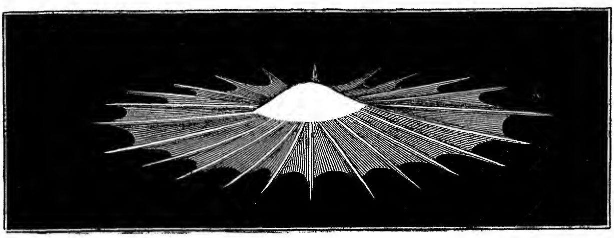


Fig. 4.

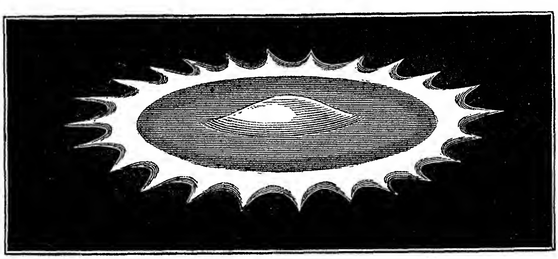


Fig. 5.

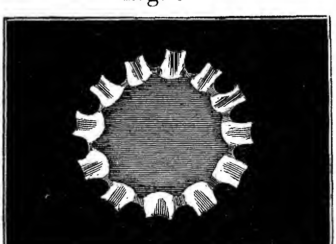


Fig. 6.

Fig. 7.

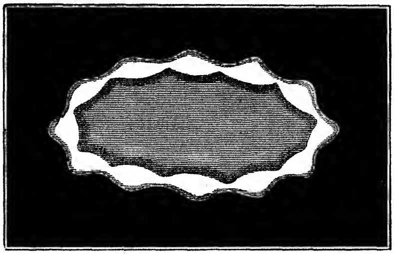
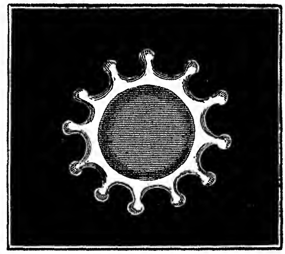


Fig. 8.



Set 1 of the drawings represents the forms most usually assumed by a drop of mercury 3·76 millims. in diameter falling on a clean glass plate from a height of 78 millims.

I will speak of variations afterwards.

Fig. 1. Rays, too numerous to allow of an estimate of their number, shoot out from the point of contact. The inner ends of these join, forming a continuous sheet of liquid, in which the upper part of the drop may be seen reflected.

Fig. 2. The liquid flows from above, over the rays, which shoot out still further.

Fig. 3. Main rays are seen, apparently symmetrically disposed about the centre, and connected by a thinner sheet of either continuous liquid or very fine rays. Very often drops split off from the ends of the main rays, and were left on the plate in a more or less complete circle. The number of these seemed to have been in most cases 24. Often there was no doubt of this, and sometimes there may have been 21 and 28. I have accordingly drawn the figure with 24 rays.

Fig. 4. The rays, having reached their maximum spread, are overtaken by the liquid, which rises in a convex ring and overflows them.

Fig. 5 shows the beginning of a transition from 24 rays to 12 arms. The liquid flows up and joins the rays in pairs.

Fig. 6 shows a later stage of the transition.

Fig. 7 shows the drop with 12 arms just beginning.

Fig. 8. The liquid begins to contract and feed the arms.

The stages later than this were described in my previous paper.

Set 2.

Fig. 1.

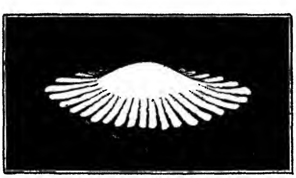


Fig. 2.

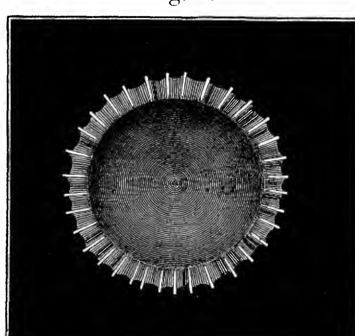


Fig. 3.

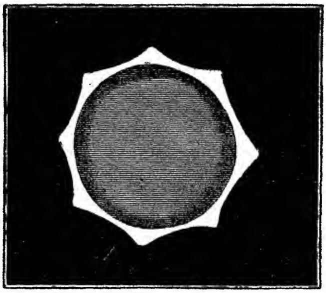
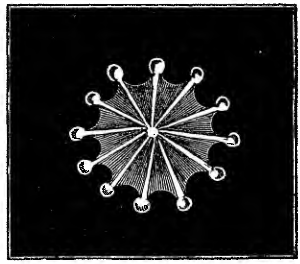


Fig. 4.



SET 2 exhibits variations.

Fig. 1 is a variation of fig. 2, Set 1, the rays being rather fewer and lobed at the ends. This was only seen once, and then no drops split off to be left on the plate.

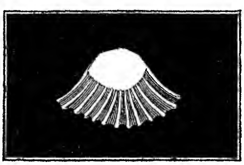
Fig. 2. This is inserted here as a variation of fig. 4, Set 1, viewed from above, though it was really seen with a greater height of fall (205 millims.). There is a slight convexity at the edge, and the rays are only visible there.

Fig. 3 is a variation of fig. 7, Set 1, where the figure had, as near as could be estimated, 8 lobes.

Fig. 4 is a frequently seen variation of fig. 8, Set 1, the rays being visible to the centre, joined by a thinner film of liquid.

SET 3.

Fig. 1.



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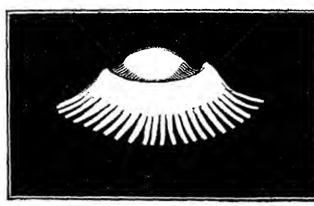

SET 3 shows two early stages seen with a drop of milk 4·22 millims. in diameter falling from a height of 30 millims. on to smoked glass.

The early stages with milk (or, what was rather less convenient, water coloured white with finely powdered flint) did not differ markedly from those of mercury.

By increasing the height of fall to 130 millims. the number of rays as indicated by the drops left on the plate was increased to 27, and with a height of fall of 270 millims. the number became 48, or sometimes somewhere about 60, the drops being smaller.

By increasing the size of the drop the number of rays was increased also. Thus with a drop of four times the cubical contents of those mentioned, and falling from a height of 78 millims., the number of drops left on the plate was often 36, and the drops were larger, and, indeed, the whole phenomenon was on a larger scale.

In counting the drops on the plate, judgment is required in distinguishing drops that have split off the rays from those that have split off later from the arms. Often the arrangement on the plate is so confused that no estimate can be made; at other times great regularity of the arrangement gives a probability almost amounting to certainty to the estimate.

The number of arms, as in fig. 8, Set 1, was estimated by judging of the angle between alternate arms. The estimate was sometimes confirmed by drops splitting off the arms and being left on the plate, as in the case of the rays. Thus I am pretty certain that, with a height of fall of 270 millims., the number of arms was often 18.

I may mention that I have obtained "patterns" on thinly smoked glass, made by drops of oil and mercury falling in an approximate vacuum of a pressure of 20 millims. of mercury. The marks thus obtained differ from those made in air, the central spot of lampblack being smaller in the case of air. For low heights of fall the difference is not perceptible, but it becomes very marked as the height is increased from 100 to 500 millims.

With a liquid which wets the surface on which it falls (as, for instance, milk on glass) I find that the earliest stages are very similar to the first two of Set 1; but no well-marked main rays are seen, as in fig. 3. The annular ridge of fig. 4 is seen to overflow the slightly protruding rays, and form a figure like number 7, with slight undulations which do not afterwards increase into arms.

It is, I think, worthy of remark that in the case of mercury on smoked glass, where the adhesion is least, the main ridges appear early before the drop is much spread out. On a clean glass, where the adhesion is greater, the main ridges first appear rather later, and are somewhat less strongly marked; while with milk on a clean glass, to which it adheres strongly, no ridges are seen at all.

IV. "Preliminary Note on the Development of Organisms in Organic Infusions." By JOHN TYNDALL, F.R.S. Received January 18, 1877.

I beg leave to submit to the Royal Society a brief preliminary note of the results obtained in the further prosecution of my researches "On the Optical Deportment of the Atmosphere, with reference to Putrefaction and Infection."

The very remarkable experiments of Dr. Roberts, of Manchester, which have been confirmed by Professor Cohn, of Breslau, have been both verified and contradicted by my recent researches. In some cases alkalized hay-infusions have been completely sterilized by boiling for five minutes, in other cases they have withstood the boiling temperature for a far longer period.

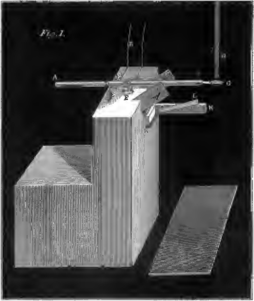
Fig. 1.
A
B
G
E
K

Set 1.

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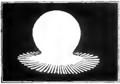
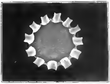


Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.



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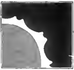

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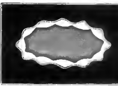

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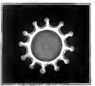

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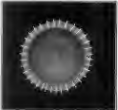

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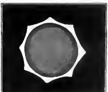

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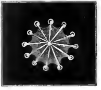

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